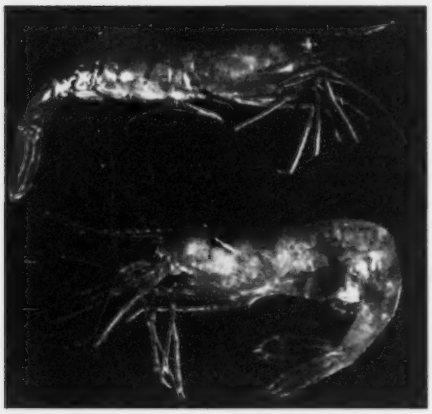
Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Central and Arctic Region
Canadian Science Advisory Secretariat
Science Advisory Report 2011/010

ASSESSMENT OF NORTHERN SHRIMP (*Pandalus borealis*) AND STRIPED SHRIMP (*Pandalus montagui*) IN WESTERN AND EASTERN ASSESSMENT ZONES (SFA 2 AND 3)



*Top: Northern Shrimp (*Pandalus borealis*)*
*Bottom: Striped Shrimp (*Pandalus montagui*)*

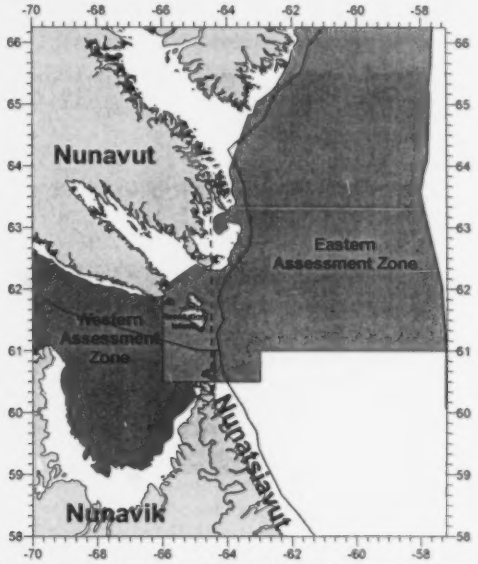


Figure 1. Eastern and Western assessment zones which underlay Shrimp Fishing Area 2 (east of blue dashed line) and 3 (west of blue dashed line). Boundaries of the Nunavut, Nunavik and Nunatsiavut land claims are shown in red.

Context :

*Fisheries and Oceans Canada (DFO) Resource Management (RM) has requested Science advice on the status of the two species of shrimp, Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*P. montagui*) in the waters adjacent to Nunavut. Both species were last assessed in 2010 (DFO 2010). Assessments are planned every two years however concerns for the fishery in shrimp fishing areas (SFA) further south prompted an assessment ahead of schedule.*

Proposed changes to the management of the shrimp fishery in SFA 2 and 3 are being considered by RM. Science proposed two new assessment zones to make better use of the current surveys in the assessment process. These zones were adopted at this zonal science advisory process (ZAP), held in St. John's NL 15-25 February 2011. Future ZAPs will assess the populations based on the Western Assessment Zone and the Eastern Assessment Zone.

This assessment follows the framework developed in 2007 for Northern Shrimp off Labrador and the northeastern coast of Newfoundland (DFO 2007a). A series of fishery-independent surveys and fishery data formed the basis of the current assessment. Since the last assessment, new data are only available for the Eastern Assessment Zone. At this ZAP it was agreed that advice from 2010 corresponding to the Western Assessment Zone would be carried forward into this report.

SUMMARY

- The thermal regime has been warming over the past five years. Effects of a warm regime on shrimp distribution and behaviour are unknown. However any effect may be greater on *Pandalus montagui* than *P. borealis* because of its preference for cooler waters.
- Two new assessment zones for the assessment of the *Pandalus* resources in the Arctic were adopted. As no new information was available for the Western Assessment Zone, no new advice was formulated. The advice from the 2010 assessment corresponding to this zone was carried forward.
- *Pandalus borealis* and *Pandalus montagui* were assessed in the new Eastern Assessment Zone.
- Since the 2010 assessment, one Northern Shrimp Research Foundation (NSRF)-DFO survey of SFA 2 Exploratory (EX) and Resolution Island Survey Area (RISA) provided the fishery-independent data for this assessment.
- Survey biomass, fishery data and fishery exploitation rate indices are used to assess the resources.

Eastern Assessment Zone – *P. borealis*

- The catch varied without trend at about 6,000 t since 1996.
- CPUE shows a strong upward trend in the time series but is believed to reflect changes in fishing patterns not resource status.
- Survey data are available for the period of 2006–2010, however the first two years are not considered to be comparable with the rest of series.
- Fishable biomass and female spawning stock biomass indices have not changed significantly over the period 2008-2010. The fishable biomass index was about 42,500 t from 2008–2010 and the female spawning stock biomass index was about 24,000 t from 2008–2010.
- Recruitment is uncertain.
- The observed exploitation rate index has varied without trend since 2007/08 around a mean of 9%.
- Under the Integrated Fisheries Management Plan Precautionary Approach Framework, the female spawning stock biomass has been in the Healthy Zone for the past four years but only the last three years are considered informative. The exploitation rate over this period has averaged 9% which is below the base target expioitation rate of 15% for the Healthy Zone.

Eastern Assessment Zone – *P. montagui*

- The catch declined steadily from about 4,000 t in 1999 to about 500 t in 2009/10. This is thought to be a consequence of changes in fishing patterns, market conditions and alternative fishing opportunities after 1999.
- Survey data are available for the period of 2006–2010 however the first two years are not considered to be comparable with the rest of series.
- Fishable biomass and female spawning stock biomass indices decreased in 2010. This may be caused by a distributional shift away from warmer water. The fishable biomass index was about 15,000 t in 2008–2009 and 7,400 t in 2010. The female spawning stock biomass index was 11,000 t in 2008 and 5,800 t in 2010.
- Recruitment is uncertain.
- The observed exploitation rate index has varied without trend since 2007/08 around a mean of 5%.

- The potential exploitation rate index based on total TAC has varied without trend since 2007/08 around a mean of 56%.
- Female spawning stock biomass has declined into the Cautious Zone of the Integrated Fisheries Management Plan Precautionary Approach Framework and is slightly below the Upper Stock Reference.

Western Assessment Zone[1] – *P. borealis*

- Resource status is based on two survey years, 2007 and 2009 using the Cosmos trawl.
- Fishable biomass index for the two years was 14,600 t (2007) and 15,500 t (2009).
- Female spawning stock biomass index was 3,200 t (2007) and 3,800 t (2009).
- Recruitment is uncertain.
- Prospects are uncertain due to limited data.

Western Assessment Zone[1] – *P. montagui*

- Resource status is based on two survey years, 2007 and 2009 using the Cosmos trawl.
- Fishable biomass index was 48,400 t (2007) and 46,700 t (2009).
- Female spawning stock biomass index was 16,700 t (2007) and 18,000 t (2009).
- Recruitment is uncertain.
- Prospects are uncertain due to limited data.

BACKGROUND

Species Biology

Northern Shrimp (*P. borealis)* are found in the Northwest Atlantic from Baffin Bay to the Gulf of Maine, and Striped Shrimp (*P. montagui)* are found from Davis Strait south to the Bay of Fundy. Both species have preferred depth and temperature distributions. *P. montagui* prefers cooler water (-1 to 2°C) than *P. borealis* (0 to 4°C). These cooler waters tend to occur in shallower depths. The main density of *P. borealis* tends to occur at 300-500 m while *P. montagui* occur mainly in 200-500 m. Northern Shrimp are associated with soft substrates whereas Striped Shrimp prefer harder bottoms.

Both species of shrimp are protandric hermaphrodites, functioning as males early in their lives then changing sex and reproducing as females for the remainder of their lives. Females usually produce eggs once a year in the late summer-fall and carry them, attached to their abdomen, through the winter until the spring, when they hatch. Newly hatched shrimp spend three to four months as pelagic larvae. At the end of this period they move to the bottom and take up the life style of the adults. Both species migrate into the water column during the night. The migration consists mainly of males and smaller females. Shrimp are opportunistic feeders on or near the sea floor and in the water column. Shrimp ageing is uncertain but shrimp in the north are thought to live five to eight years. Growth rates and maturation are likely slower in northern populations. *Pandalus* shrimp are important forage species.

[1]The Western Assessment Zone was not assessed at the February 2011 zonal assessment process (ZAP) because there were no new survey data. Advice from the 2010 ZAP for the area corresponding to the new Western Assessment Zone was carried forward.

Fishery

The fishery is managed by Total Allowable Catch (TAC). Access to the fishery is limited to 17 offshore license holders, and to Nunavut with special quota allocations managed by the Nunavut Wildlife Management Board (NWMB) to be fished within the Nunavut Settlement Area (NSA). The NWMB sub-allocates its quota to Hunters and Trappers Organizations and other Nunavut interests. All fishing to date has been conducted by large vessels (>500 t) with 100% observer coverage.

Fishing gear consists of single and, more recently, twin shrimp trawls requiring a minimum codend mesh size of 40 mm and Nordmøre separator grate (maximum 28 mm bar spacing). Since 2003, the management year has been 1 April to 31 March. The fishing season is limited by the extent of sea ice, and is conducted between May and December in most years.

P. borealis has been the main commercial species throughout the history of the shrimp fishery in this area. Directed *P. montagui* fishing does occur but most of the harvest occurs as by-catch in the directed *P. borealis* fishery.

The fishery began in the late 1970s in SFA 1. Exploratory fishing expanded into northern SFA 2 and then to areas southeast of Resolution Island in Hudson Strait. Quotas in these areas were based on fishery performance and not scientific survey data. In the mid-1990s, the fishery moved southeast of Resolution Island in SFA 2, where the main fishery remains to date. Implementation of the Nunavut Land Claims Agreement in 1999 shifted the main fishery east of the NSA. Over the last eight years the distribution of fishing effort has remained unchanged.

ASSESSMENT

This is an assessment of both *P. borealis* and *P. montagui*. These two species have overlapping distributions, especially in the Resolution Island area, resulting in an overlap of their fisheries. The total removal, both directed catch and by-catch, of each species is considered in the assessment.

New information considered in this assessment is the 2010 NSRF-DFO survey of the Eastern Assessment Zone (RISA-W, RISA-E and SFA 2EX survey areas, Fig. 2). Survey data are available for the period of 2006–2010 however the first two years are not considered to be comparable with the rest of the series because of incomplete coverage and operational issues. Only the period 2008–2010 is considered in the current assessment.

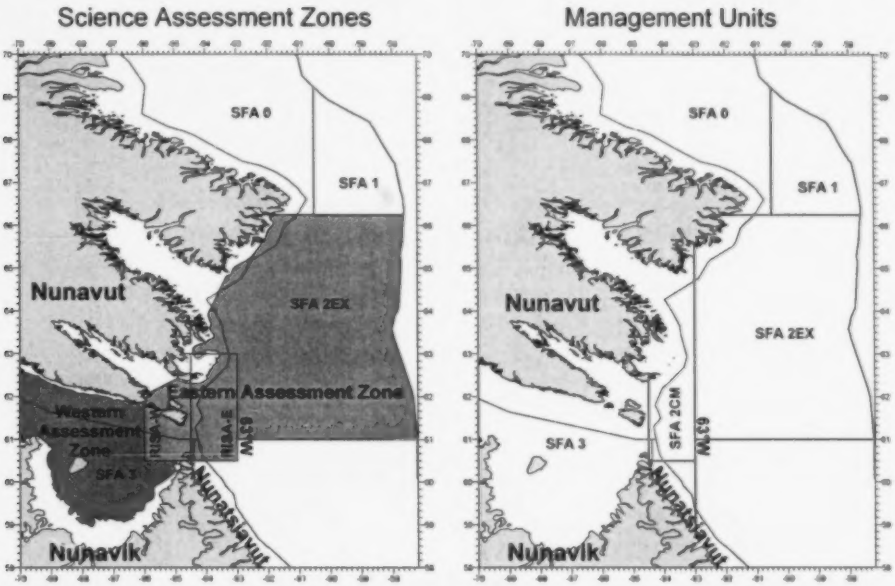


Figure 2. Location of the six survey areas (left panel) and the five management units (right panel) mentioned in this Science Advisory Report. SFAs 0 and 1 were not included in this assessment. SFA 1 is part of the straddling Greenland shrimp stock which Canada shares with Greenland. It is assessed annually by the Northwest Atlantic Fisheries Organisation. No new information was available for SFA 0. Boundaries of the Nunavut, Nunatsiavut and Nunavik Land Claim Areas are identified with red lines. Shrimp Fishing Area (SFA), Commercial (CM), Exploratory (EX), Resolution Island Study Area (RISA), East (E), West (W).

The assessment follows the framework established by DFO (2007a) where possible. Fishery data, and fishable and female spawning stock biomass (SSB) indices form the basis of the assessment. Fishable biomass is based on male and female shrimp from the surveys with a carapace length greater than 17 mm. SSB is based on all female shrimp from the surveys regardless of size. The recruitment index is based on the abundance of shrimp from 11.5 to 17 mm carapace length. An acceptable methodology to calculate total instantaneous mortality (Z) has not been found and therefore was not included as part of the assessment. The observed exploitation rate index was calculated as catch from observer records divided by the fishable biomass index from the same year. The potential exploitation rate index was also calculated assuming the entire TAC was taken. Bootstrapped 95% confidence intervals have been included for each of the indices. A change in the method for calculating these confidence intervals resulted in tighter intervals. Point estimates were not affected.

For this assessment, population status was evaluated within the Precautionary Approach (PA) framework (DFO 2006). Reference points (RP) were developed for shrimp (DFO 2009) and implemented in the Integrated Fisheries Management Plan (IFMP) (DFO 2007b). Proxies for the RPs were based on the geometric mean of SSB. The Limit Reference Point (LRP) is 30% of the mean and the Upper Stock Reference (USR) is 80% of the mean.

The Western Assessment Zone was surveyed with the Greenland Institute of Natural Resources' research vessel Paamiut using a Cosmos trawl. The Eastern Assessment Zone was surveyed with the commercial fishing vessel Cape Ballard using a Campelen trawl which has been modified over the time series. The standard Campelen was used for the whole Zone in

2006 and 2007, the standard trawl was used in SFA 2EX in 2008 but a Campelen trawl with modified footgear was used in RISA; from 2009 onward the Campelen with modified footgear was used in the whole Zone.

Strong tidal currents in Hudson Strait, up to five knots, could result in quick shifts in shrimp distribution and catchability. This is an added complication when interpreting the trawl survey data.

Eastern Assessment Zone – *P. borealis*

Fishery

Since 1994, the majority of catch taken in the Eastern Assessment Zone comes from SFA 2 southeast of Resolution Island and east of the Nunavut and Nunavik land claims borders. A small portion of the catch is taken east of 63°W in SFA 2EX.

In the Eastern Assessment Zone, total catches (directed and by-catch) of *P. borealis* varied without trend at about 6,000 t since 1996. Canadian Atlantic Quota Report (CAQR) is reporting a catch of 6,143 t as of 3 February 2011 so it is unlikely that the TAC (9,150 t) will be taken for 2010/11. Ice conditions in the zone have been favourable for fishing late into the 2010/11 management year so CAQR may also be under reported. Since 1998, only the SFA 2CM quota (offshore) has been taken annually (Fig. 3).

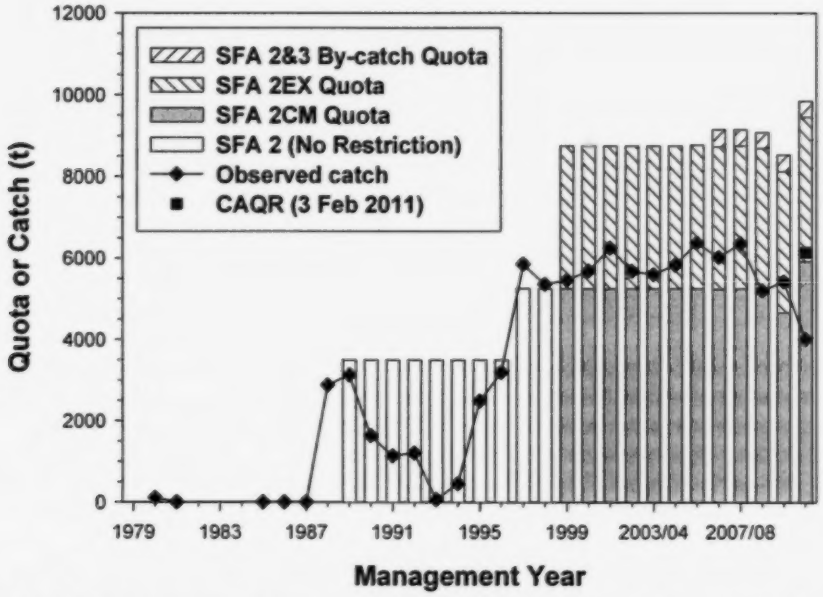


Figure 3. The Eastern Assessment Zone Pandalus borealis *TAC and catch recorded by the observer program. Observer catch records are incomplete for 2010/11 but CAQR as of 3 Feb 2011 reports 6,143 t. SFA 2CM is the area of SFA 2 west of 63°W and SFA 2EX is to the east.*

CPUE in the Eastern Assessment Zone shows a strong upward trend in the time series but is thought to reflect changes in fishing patterns not stock status (Fig. 4). CPUE was significantly higher during the past two years but the observer data for 2010/11 is incomplete. The reasons for the recent sharp increase are unknown.

Figure 4. The Eastern Assessment Zone unstandardized CPUE index for directed Pandalus borealis *fishing. Observer records for 2010/11 season are incomplete.*

Biomass

The fishable biomass and SSB indices have not changed significantly over the period 2008–2010 (Fig. 5). The fishable biomass index was about 42,500 t from 2008–2010 and SSB index was about 24,000 t from 2008–2010.

Recruitment

Recruitment is uncertain. Currently, there is no recruitment index for this area but work continues to develop one.

Exploitation

The observed exploitation rate index varied without trend since 2007/08 averaging 9% (Fig. 6). The potential exploitation rate index based on total TAC has also varied without trend since 2007/08 averaging 14%. Most of the fishery is concentrated in the southern portion of SFA 2CM.

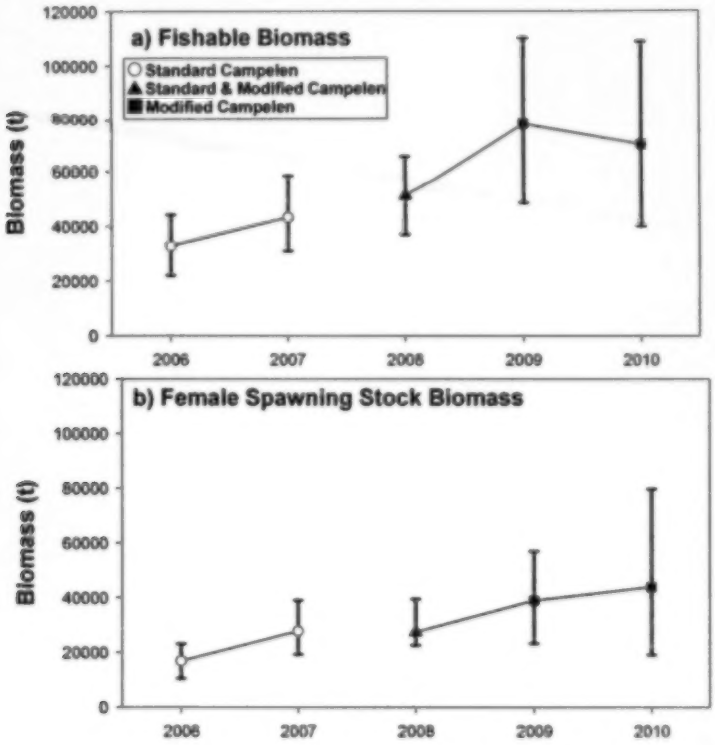


Figure 5. The Eastern Assessment Zone fishable and female spawning stock biomass indices of Pandalus borealis *for the survey years 2006-2010. The first two years of survey data (2006-2007) are not considered to be comparable with the rest of series because of poor trawl performance around Resolution Island.*

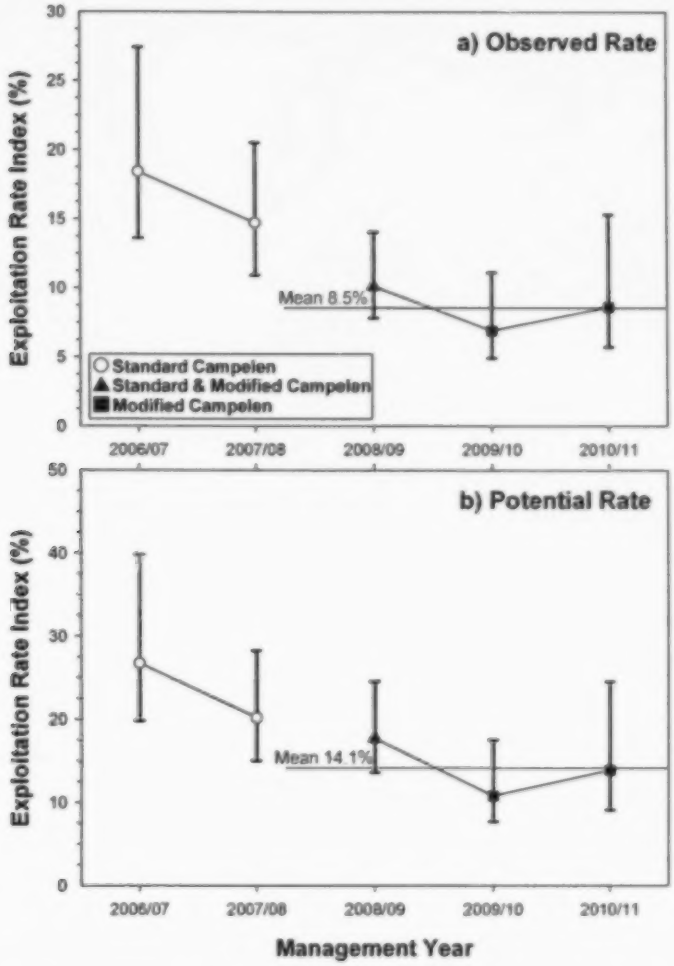


Figure 6. The Eastern Assessment Zone Pandalus borealis *exploitation rate indices for a) the observed rate based on the catch taken and b) the potential rate if the TAC assigned to the Eastern Assessment Zone was taken. The first two years of survey data (2006-2007) are not considered to be comparable with the rest of series because of poor trawl performance around Resolution Island.*

Current Outlook and Prospects

Under the IFMP PA framework, the SSB for the Eastern Assessment Zone has been in the Healthy Zone for the past three years (Fig. 7). The exploitation rate over this period has averaged 9% which is below the base target exploitation rate for the Healthy Zone of 15%.

The current IFMP reference points, based on 2006-2008 surveys (DFO 2007b), may no longer be appropriate because they were based on a short survey time series which included two years of data not considered comparable with the rest of the series and the assessment area has changed. Some consideration, both by Science and RM, should be given to the minimum time series required to set appropriate reference points.

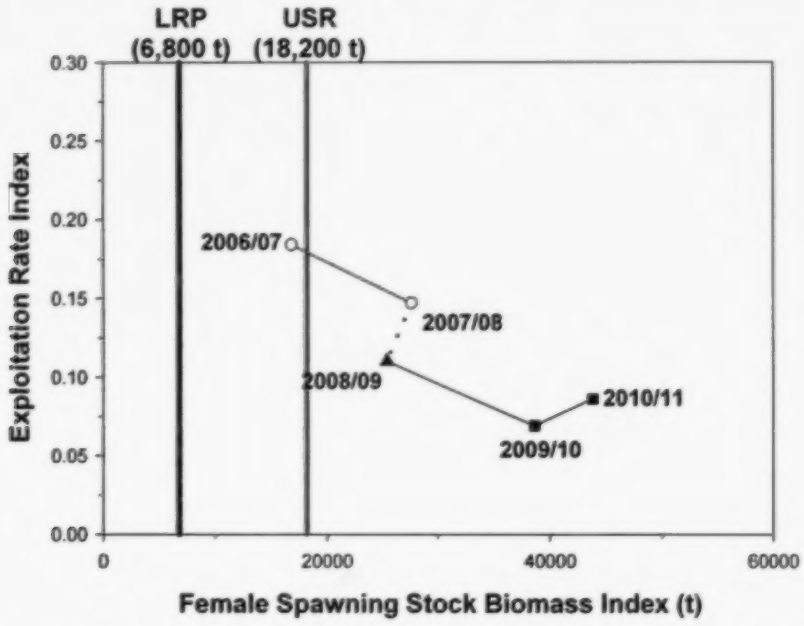


Figure 7. The Eastern Assessment Zone trajectory of Pandalus borealis *female spawning stock biomass (SSB) and exploitation rate in relation to reference points from the IFMP for SFA 2. USR=Upper stock reference and LRP=limit reference point are 80% and 30% respectively of the geometric mean of the SSB index. (O = standard Campelen trawl, ▲ = mix of standard and modified Campelen, ■ = modified Campelen)*

Eastern Assessment Zone – *P. montagui*

Fishery

The majority of *P. montagui* catch is taken as by-catch in the directed fishery for *P. borealis* in SFA 2CM south of 63°N. There are quotas for directed *P. montagui* fisheries within the NSA but they have not generally been taken. The catch is taken between 63°W and 64°30'W with small amounts just over the boundary in SFA 3 but none have been taken further west than 66°W in recent years. The catch declined steadily from about 4,000 t in 1999 to about 500 t in 2009/10 (Fig. 8).

The Nunavut Land Claims Agreement came into effect in 1999. As a result, the offshore industry was required to move operations within SFA 2CM (Fig. 2) from their traditional fishing area to east of the NSA. *P. montagui* biomass concentrations decline steeply from west to east in SFA 2 as reflected in the fishery catches. Also, captains have reported that they have learned to reduce by-catch of *P. montagui* in the directed *P. borealis* fishery. The decline may also be a consequence of changes in market conditions and alternative fishing opportunities since 1999. Therefore, CPUE in the Eastern Assessment Zone is not considered to reflect stock status or fishery performance.

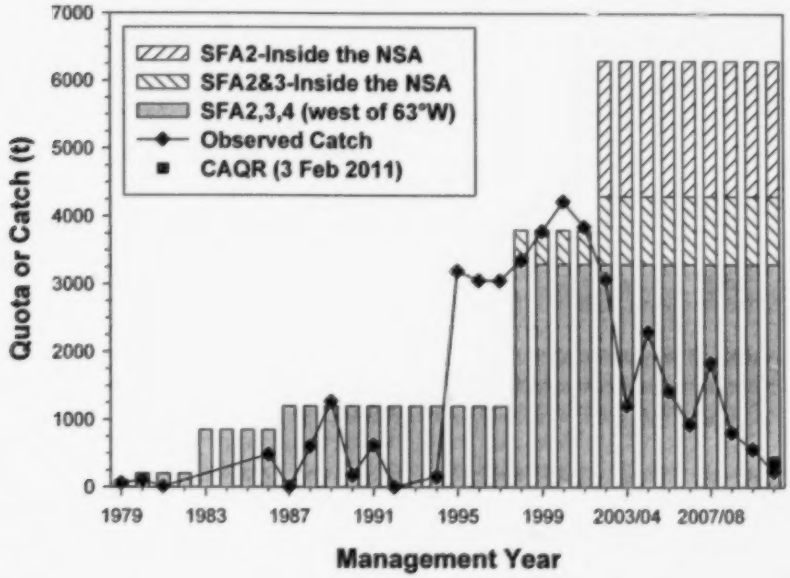


Figure 8. The Eastern Assessment Zone Pandalus montagui *TAC and catch recorded by the observer program. Observer catch records are incomplete for 2010/11 but CAQR as of 3 Feb 2011 reports 382 t. Ice conditions in the zone have been favourable for fishing late into the 2010/11 management year so CAQR may also be under reported.*

Biomass

The fishable biomass and SSB indices have decreased in 2010 (Fig. 9). Warmer bottom water temperatures existed over a much larger area in 2010 than previously. The increased temperature may have affected *P. montagui* distribution contributing to the reduction in biomass in the assessment zone. Fishable biomass index was about 15,000 t in 2008–2009 and 7,400 t in 2010. SSB index was 11,000 t in 2008 and 5,800 t in 2010.

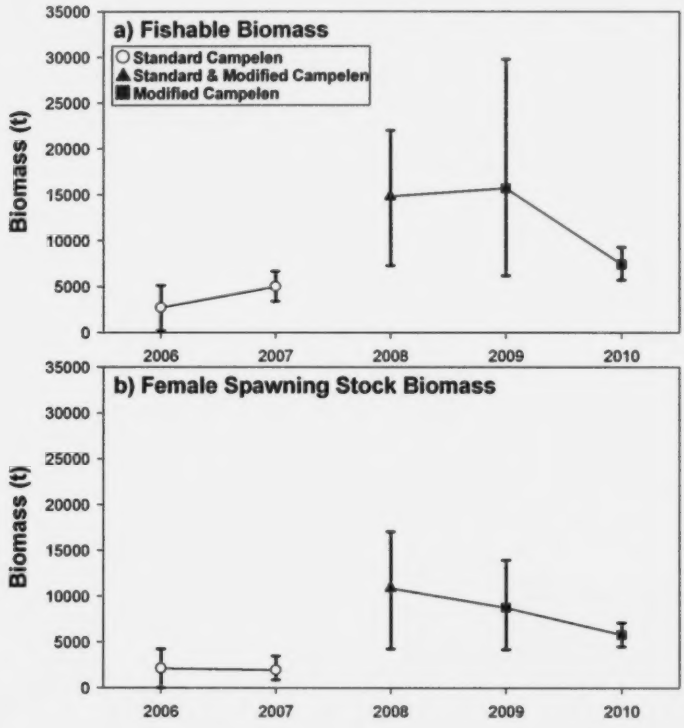


Figure 9. The Eastern Assessment Zone fishable and female spawning stock biomass indices of Pandalus montagui *in the Eastern Assessment Zone for the survey years 2006-2010.*

Recruitment

Recruitment is uncertain. Currently, there is no recruitment index for this area but work continues to develop one.

Exploitation

Discounting the first two years of the survey, not considered comparable with the rest of the series, the observed exploitation rate index varied without trend since 2007/08 averaging 5% (Fig. 10). The potential exploitation rate index based on total TAC has varied without trend since 2007/08 around a mean of 56%. Given the lower fishable biomass in 2010, the potential exploitation rate would have been 89%.

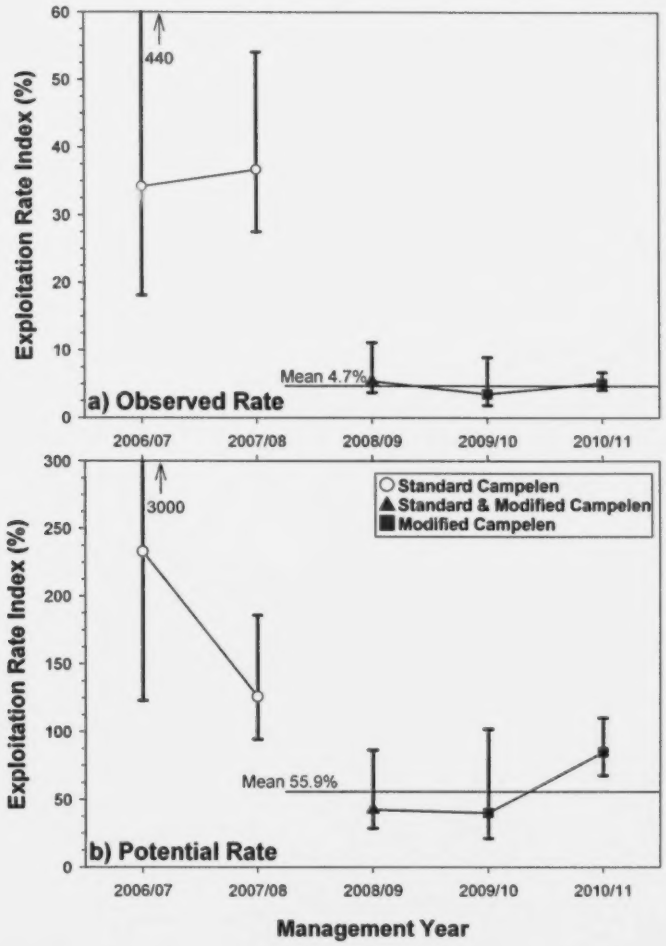


Figure 10. The Eastern Assessment Zone Pandalus montagui *exploitation rate indices for the a) observed rate, based on the catch taken and the b) potential rate if the TAC was taken. Upper confidence limit for 2006/07 is shown.*

Current Outlook and Prospects

The SSB in the Eastern Assessment Zone has moved just below the USR into the Cautious Zone (Fig. 11). This drop into the Cautious Zone has occurred without a significant catch taken by the fishery. This may have occurred as a result of a distributional shift caused by the intrusion of warm water over most of the assessment zone. *P. montagui* generally avoid water with such temperatures.

The 2009 IFMP reference points (DFO 2007b) were based on a combined biomass from SFA 2, 3 and 4 west of 63°W. This formulation was not accepted at the 2010 ZAP and therefore is not appropriate here. The 2010 ZAP produced an alternate set of reference points (DFO 2010) for the SFA 2, 3, 4 quota area between 63°W and 66°W (Fig. 11). However, since the assessment area has changed and given the short survey time series which included two years of data not considered comparable, another set of reference points may need to be developed for the

Eastern Assessment Zone. Even then, three years may be insufficient for setting reference points. Some consideration, both by Science and RM, should be given to the minimum time series required to set appropriate reference points.

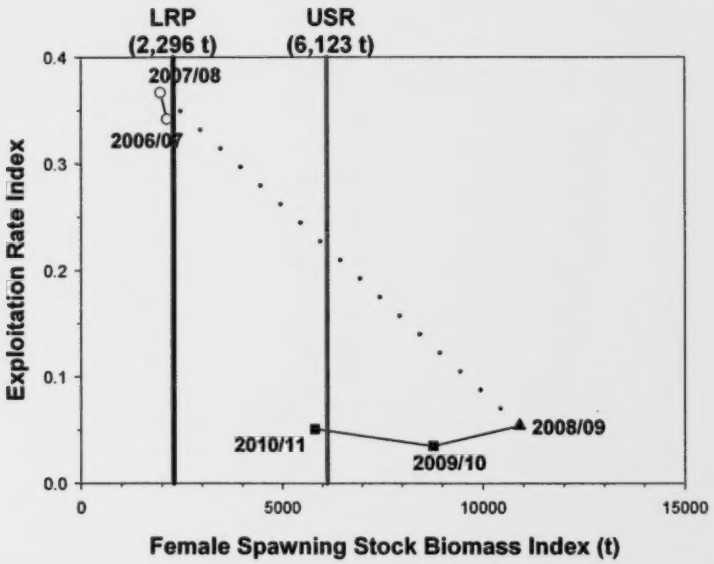


Figure 11. The Eastern Assessment Zone trajectory of Pandalus montagui *female spawning stock biomass (SSB) and exploitation rate in relation to reference points for the SFA 2, 3 and 4 between 63°W and 66°W from DFO (2010). USR=Upper stock reference and LRP=limit reference point is 80% and 30% respectively of the geometric mean of the SSB index. (O = standard Campelen trawl, ▲ = mix of standard and modified Campelen, ■ = modified Campelen)*

Western Assessment Zone – *P. borealis*

Fishery

There is no directed commercial fishery for *P. borealis* in this area.

Biomass

The assessment is based on two DFO surveys conducted in October 2007 and 2009 in SFA 3 west of RISA-W using the Cosmos trawl.

The fishable biomass index was 14,600 t (2007) and 15,500 t (2009). The SSB index was 3,200 t (2007) and 3,800 t (2009).

Recruitment

The recruitment index increased from 700 to 900 million between 2007 and 2009. Recruitment is uncertain in this area. However, the proportion of 11.5 mm to 17 mm shrimp in the Western Assessment Zone is higher than seen in other northern SFAs.

Exploitation

In recent years there has been no *P. borealis* exploitation.

Current Outlook and Prospects

The majority of *P. borealis* was found in Hudson Strait north of Akpatok Island. The Western Assessment Zone is dominated by *P. montagui* with *P. borealis* comprising 25% of the total *Pandalus* biomass. With only two surveys in the assessment zone, no resource trends can be determined. The fishable biomass index of at least 15,000 t would suggest there is potential for a *P. borealis* fishery in this area. However, there is a large proportion of smaller individuals and a mix of species in this area.

Western Assessment Zone – *P. montagui*

Fishery

There is no directed commercial fishery for *P. montagui* in this area. There are quotas for directed *P. montagui* fisheries within the NSA but have never been taken.

Biomass

The fishable biomass index was 48,000 t (2007) and 47,000 t (2009) (Fig. 12). The SSB index was 17,000 t (2007) and 18,000 t (2009).

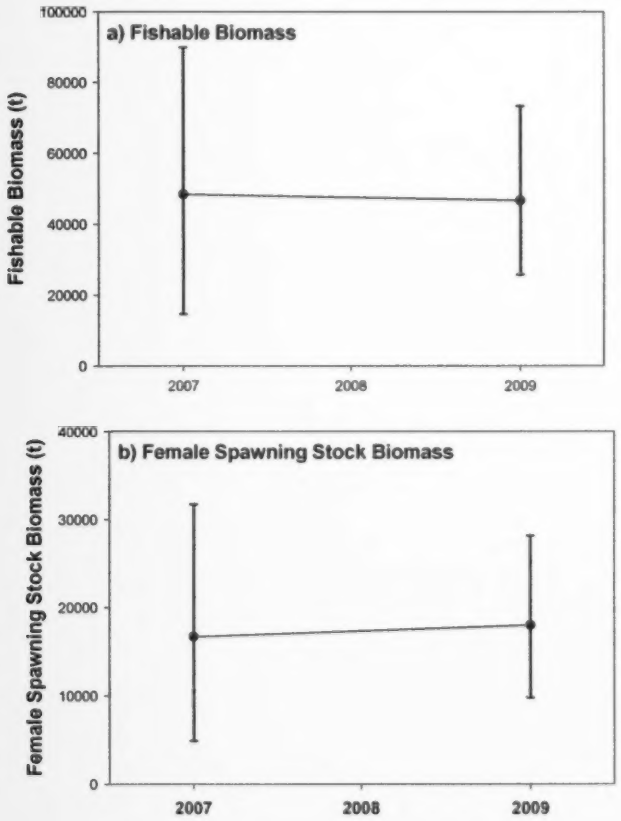


Figure 12. The Western Assessment Zone, a) Fishable biomass and b) female spawning stock biomass indices for the two years of DFO surveys.

Recruitment

Recruitment is uncertain. Currently, there is no recruitment index for this area but efforts continue to develop one.

Exploitation

In recent years there has been no *P. montagui* exploitation.

Current Outlook and Prospects

No information was included specific to the Western Assessment Zone in the 2010 SAR (DFO 2010).

Sources of Uncertainty

Hudson Strait is a highly dynamic system with strong tidal currents and mixing. Shrimp could be transported great distances in a relatively short period of time. This could result in populations shifting rapidly across the assessment zones.

Experimental work done by DFO in 2007 in the Resolution Island area suggests that results may be affected by the tidal cycle. Surveys from 2006–2008 were all conducted at the height of the spring tide, while the 2009 and 2010 surveys were conducted at neap tides to minimize the tidal effect. Regardless, the survey is conducted over a 24-hour period so strong tidal currents would still be present and may result in either an over- or underestimate of biomass.

Fishery-independent surveys are conducted annually in the Eastern Assessment Zone and biennially in the Western Assessment Zone. If there is seasonality in the distribution of shrimp and/or the catchability of the shrimp in the trawl, this could affect the assessment.

Trawls used in the surveys have catchability less than one but the exact value is unknown. Therefore, estimates produced from the surveys are the minimum observed rather than absolute levels. Catch is known; however, the total fishery induced mortality is unknown (landed catch plus incidental mortality from trawling). Exploitation rates are relative indices rather than absolute.

Modifications were made to the Campelen trawl which resulted in better spatial coverage in 2008–2010 within RISA. This provided increased confidence in the results over the data collected during the first two years although a three year time series is still too short to evaluate population trends.

In the Eastern Assessment Zone, fishery trends (CPUE) may not reflect resource abundance. Changes in fishing pattern, market value and distribution of the two species could influence CPUE. In particular, in 1999 implementation of the Nunavut Land Claims Agreement and later the Nunavik Inuit Land Claims Agreement has moved the main fishing effort slightly to the east which may have had a greater influence on CPUE for the *P. montagui* than the *P. borealis* fishery.

INDUSTRY PERSPECTIVES

Offshore Sector

Very strong tidal currents in the RISA area of SFA 2 may be negatively affecting catchability of research vessel survey sets in that area, and therefore biomass in that area may be under-estimated.

There were no significant changes observed in the large vessel commercial shrimp fishery in SFA 2.

CONCLUSIONS AND ADVICE

Eastern Assessment Zone – *P. borealis*

The current status of this resource is considered healthy based on the PA framework. Even if the TAC was taken, the exploitation rate would not exceed the base target exploitation rate for the Healthy Zone.

Eastern Assessment Zone – *P. montagui*

The resource has entered the Cautious Zone of the PA framework. Currently catches are low resulting in a low exploitation rate index (5%) because of limited directed fishing. However, the high potential exploitation rate index (56%) in the area continues to be a possible conservation concern should fishing effort increase significantly.

Western Assessment Zone – *P. borealis*

The current status of this resource is considered uncertain because the assessment is based on only two years of survey data. There is no TAC for directed *P. borealis* fishing. The fishable biomass index averaged 15,000 t suggesting there is potential for a *P. borealis* fishery in this area.

Western Assessment Zone – *P. montagui*

No information was included specific to the Western Assessment Zone in the 2010 SAR (DFO 2010). However, the current status of this resource is considered uncertain because the assessment is based on only two years of survey data. There is a 1,000 t quota for directed *P. montagui* fishing in the NSA. The average fishable biomass index of 50,000 t would suggest there is potential for increased exploitation in this area.

MANAGEMENT CONSIDERATIONS

This is an extremely complex region with multiple management areas and overlapping quotas that can be fished across management units with the added complication of two highly intermixed species overlying three adjacent land claim areas (Nunavut Settlement Area, Nunavik Marine Region and Nunatsiavut Zone). The new assessment zones used here represent the first step in simplifying the assessment of the two species. Implementing changes in management of the shrimp fishery in the north with quotas that cannot be fished across SFAs would further simplify the process.

The overlap of *P. montagui* quotas in the northern SFAs results in TAC levels which would lead to very high exploitation rate indices if fully harvested. This continues to be a concern.

In general, management of key forage species, such as shrimp, under an ecosystem approach requires adoption of a more conservative approach with lower fishing mortality reference points and higher biomass reference points than those that would be adopted under a single species management approach. Keeping the exploitation rate at or below the base target of 15% for the Healthy Zone of the PA framework is thought to be conservative and leaves forage in the water for predators.

The IFMP contains reference points for *P. montagui* based on an area that included SFA 2, 3 and 4 west of 63°W. This formulation was not accepted at the 2010 ZAP but an alternate formulation was published in the science advisory report (DFO 2010) from the meeting. However these changes are not yet reflected in the IFMP.

The reference points within the IFMP as of this ZAP are based on areas that differ from the current assessment zones. As a result, the biomass levels that defined the reference points are no longer appropriate. In addition, the survey time series used to determine the reference points is much shorter than in other SFAs and includes two years of data not considered comparable with the rest of the series in the Eastern Assessment Zone. The IFMP reference points should be adjusted to account for these concerns. Furthermore, some consideration, both by Science and RM, should be given to the minimum time series required to set appropriate reference points.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat zonal advisory process held 15-25 February 2011 on the assessment of northern and striped shrimp in Shrimp Fishing Areas (SFAs) 2-6. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

DFO. 2006. A Harvest Strategy Compliant with the Precautionary Approach. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/023.

DFO. 2007a. Assessment Framework for Northern Shrimp (*Pandalus borealis*) off Labrador and the northeastern coast of Newfoundland; 28-30 May 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/034.

DFO. 2007b. Integrated Fisheries Management Plan: Northern Shrimp - Shrimp Fishing Areas (SFAs) 0-7 and the Flemish Cap.http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/shrimp-crevette/shrimp-crevette-2007-eng.htm.

DFO. 2008. Assessment of Northern Shrimp (*Pandalus borealis*) and striped shrimp (*Pandalus montagui*) in shrimp fishing areas 0, 2 and 3. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/018.

DFO. 2009. Proceedings of the Precautionary Approach Workshop on Shrimp and Prawn Stocks and Fisheries; November 26-27, 2008. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2008/031.

DFO. 2010. Assessment of Northern Shrimp (*Pandalus borealis*) in SFA 0, 2, 3 and Striped Shrimp (*Pandalus montagui*) in SFA 2, 3 and 4 west of 63°W. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/024.

FOR MORE INFORMATION

Contact: Tim Siferd
Fisheries and Oceans Canada
501 University Crescent
Winnipeg, MB
R3T 2N6
Tel: (204) 984-4509
Fax: (204) 984-2403
E-Mail: Tim.Siferd@dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice (CSA)
Central and Arctic Region
Fisheries and Oceans Canada
501 University Crescent
Winnipeg, MB
R3T 2N6

Telephone: (204) 983-5131
Fax: (204) 984-2403
E-Mail: xcna-csa-cas@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)
© Her Majesty the Queen in Right of Canada, 2011

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2011. Assessment of Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in Western and Eastern assessment zones (SFA 2 and 3). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/010.